REMARKS ✓

Claims 59, 62, 63 and 66 have been amended and claims 71-78 have been added. Claims 24, 45 and 52-78 remain pending in the instant application. Reconsideration of the application is requested in view of the amendments and the remarks to follow.

The Office Action states (p. 2, item 1) that the proposed drawing correction and substitute sheets of formal drawing have been approved. The Office Action also states that "A proper drawing correction or corrected drawings are required in reply to the Office Action to avoid abandonment of the application. The correction to the drawings will not be held in abeyance."

Accordingly, Applicants enclose a second set of revised formal drawing. No second set of the marked-up-in-red drawings showing the corrections is enclosed because the Examiner has explicitly indicated that the revised drawings are approved. Clarification is requested.

Additionally, Applicants request that a Notice of Draftperson's Patent Drawing Review (Form PTO-948) be provided with the next Office Communication. Applicants request that the Examiner inform Applicants of the status of the drawing (see, e.g., Item 10 on the Office Action Summary form).

Claims 59-70 stand rejected under 35 U.S.C. §112, second paragraph. Claims 59, 62, 63 and 66 have been amended in accordance with the concerns noted in the Office Action and/or to address minor informalities

noted during review, however, these amendments are not intended to alter the scope of the claims.

The Examiner states (p. 3) that with respect to claim 66, it is not clear that the first refractory phase, in annealing, would include the stress inducing atoms therein and/or the compressive stress inducing material. Claim 66 explicitly recites "disposing including introducing stress inducing atoms into the refractory metal silicide". The claim clearly recites that disposing stress-inducing material includes introduction of stress-inducing atoms.

Applicants respectfully submit that this complies with the requirements of 35 U.S.C. §112. Applicants note the requirements of MPEP §2173.04, entitled "Breadth Is Not Indefiniteness".

This MPEP section states that: "Breadth of a claim is not to be equated with indefiniteness. *In re Miller*, 441 F.2d 689, 169 USPQ 597 (CCPA 1971). If the scope of the subject matter embraced by the claims is clear, and if applicants have not otherwise indicated that they intend the invention to be of a scope different from that defined in the claims, then the claims comply with 35 U.S.C. 112, second paragraph."

The Examiner states (p. 3) that, with respect to claim 66, "it is not clear how "stress inducing material" is disposed operationally coupled to the refractory metal silicide." The phrase "disposing stress inducing material operationally coupled to the refractory metal silicide" is an example of what is known in patent parlance as "functional language".

Applicants note that MPEP §2173.05(g), entitled "Functional Limitations" addresses these issues. This MPEP section states that "A functional limitation is an attempt to define something by what it does, rather than by what it is (e.g., as evidenced by its specific structure or specific ingredients). There is nothing inherently wrong with defining some part of an invention in functional terms. Functional language does not, in and of itself, render a claim improper. *In re Swinehart*, 439 F.2d 210, 169 USPQ 226 (CCPA 1971)."

This MPEP section also states that "A functional limitation must be evaluated and considered, just like any other limitation of the claim, for what it fairly conveys to a person of ordinary skill in the pertinent art in the context in which it is used. A functional limitation is often used in association with an element, ingredient, or step of a process to define a particular capability or purpose that is served by the recited element, ingredient or step."

Dependent claims 67 and 68 provide examples of how the stress inducing material may be operationally coupled to the refractory metal silicide. The claims, as filed and as amended, comply with the requirements of 35 U.S.C. §112, 2ND ¶.

Claims 45, 55, 57 and 58 stand rejected under 35 U.S.C. §102(a) as being anticipated by Kawamura, JP 8139056. Claims 24, 52-54, 59-66 and 68-70 stand rejected under 35 U.S.C. §102(e) as being anticipated by, or alternatively, under 35 U.S.C. §103(a), as being unpatentable over, Apte et al., U.S. Patent No. 5,593,924. Claims 24 and 52 stand rejected under 35

U.S.C. §102(e) as being anticipated by, or alternatively, under 35 U.S.C. §103(a) as being unpatentable over, Cabral et al., U.S. Patent No. 5,828,131. Claims 45, 55-57 and 67 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Apte et al. in view of Kawamura et al. Applicants disagree and request reconsideration.

Anticipation is a legal term of art. Applicants note that in order to provide a valid finding of anticipation, several conditions must be met: (i) the reference must include every element of the claim within the four corners of the reference (see MPEP §2121); (ii) the elements must be set forth as they are recited in the claim (see MPEP §2131); (iii) the teachings of the reference cannot be modified (see MPEP §706.02, stating that "No question of obviousness is present" in conjunction with anticipation); and (iv) the reference must enable the invention as recited in the claim (see MPEP §2121.01). Additionally, (v) these conditions must be simultaneously satisfied.

The §102 rejection of claims 24, 45 and 52-70 is believed to be in error. Specifically, the PTO and Federal Circuit provide that §102 anticipation requires that each and every element of the claimed invention be disclosed in a single prior art reference. *In re Spada*, 911 F.2d 705, 15 USPQ2d 1655 (Fed. Cir. 1990). The corollary of this rule is that the absence from a cited §102 reference of any claimed element negates the anticipation. *Kloster Speedsteel AB, et al. v. Crucible, Inc., et al.*, 793 F.2d 1565, 230 USPQ 81 (Fed. Cir. 1986).

The Examiner states (p. 6) that "Kawamura et al teaches the claimed method of forming a refractory metal silicide comprising steps: providing a compressive stress inducing material (9, fig. 5B) over a first side of a substrate (1); forming a refractory metal silicide (6, 7, Titanium silicide C49, fig. 5B) over the compressive stress inducing material (9), the metal silicide comprising a first crystalline phase (C49); after forming the refractory metal silicide, annealing the refractory metal silicide comprising the first crystalline phase to form a refractory metal silicide of a second crystal phase (6, 7, titanium silicide C54, fig. 5C)." A similar argument is made (p. 7) with respect to Fig. 2. The Examiner is mistaken on multiple grounds, as is explained below in more detail.

First, Fig. 5 illustrates an arrangement whereby a Ti layer 9 and a TiN layer 10 are formed on a rear surface of a silicon substrate 1. The layers 9 and 10 are chosen (p. 15 of translation) to have a much higher thermal coefficient of expansion than <u>the silicon substrate</u> 1. As a result, the rear surface of the substrate 1 is put into dilatation, in turn causing the front surface to be put into compression. This causes the layers 6 and 7 to be put into compression. Accordingly, the layers 9 and 10 cause both dilatation and compression, but only in conjunction with the material comprising the substrate 1. The layers 9 and 10 thus are not compressive-stress inducing layers, as is positively recited in claim 45. Accordingly, the cited portion of Kawamura et al. with respect to Fig. 5 <u>does not provide the claimed elements</u> as recited in claim 45, and cannot anticipate claim 45.

Specifically, Kawamura et al. fail to teach or disclose "forming a refractory metal silicide over the compressive stress inducing material layer", as recited in claim 45. Accordingly, the reference fails to provide "the identical invention" as recited in the claim and as is required in order to find anticipation. Accordingly, the anticipation rejection based on Kawamura et al.'s Fig. 5 is defective and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Second, the layer 11 of Fig. 2 relied on by the Examiner is not a compressive-stress inducing layer, as is erroneously alleged by the Examiner. Those of ordinary skill in the relevant arts will immediately note that the layer 11 in Fig. 2B results in expansion, or dilatation, and not compression, of the layers 6 and 7, as is evident from the convex shape of the substrate 1 incorporating such layer. The layers 6 and 7 are only put into compression by removal of the layer 11. The layer 11 thus is not a compressive-stress inducing layer, as is positively recited in claim 45. Accordingly, the cited portion of Kawamura et al. with respect to Fig. 2 does not provide the claimed elements as recited in claim 45, and cannot anticipate claim 45. Accordingly, the anticipation rejection based on Kawamura et al.'s Fig. 2 is defective and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Third, Applicants note the requirements of MPEP §2121.01, entitled "Use of Prior Art in Rejections Where Operability Is In Question". This MPEP section states that "In determining that quantum of prior art disclosure which

is necessary to declare an applicant's invention 'not novel' or 'anticipated' within section 102, the stated test is whether a reference contains an 'enabling disclosure'... ." *In re Hoeksema*, 399 F.2d 269, 158 USPQ 596 (CCPA 1968). A reference contains an "enabling disclosure" if the public was in possession of the claimed invention before the date of invention.

Claim 45 recites "A method of forming a refractory metal silicide comprising: forming a compressive stress inducing material layer over a first side of a substrate; forming a refractory metal silicide over the compressive stress inducing material layer, the refractory metal silicide comprising a first crystalline phase; and after forming the refractory metal silicide comprising a first crystalline phase, annealing the refractory metal comprising a first crystalline phase to form a refractory metal silicide of a second crystalline phase", which is not taught or disclosed by Kawamura et al. Additionally, Kawamura et al. fail to enable the claimed invention, as is required in order to make a valid finding of anticipation.

There is no teaching identified in the Office Action or Kawamura et al. of "forming a refractory metal silicide over" any compressive stress inducing material layer. Accordingly, Kawamura et al. cannot possibly enable such. Accordingly, the anticipation rejection based on Kawamura et al. is defective and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Fourth, and more specifically, the interpretation that the Examiner appears to be placing on the teachings of Kawamura et al. is that when the substrate is in the position illustrated by Kawamura et al., the refractory metal

silicide layer 6, 7 (Figs. 1B-1D, explanatory text on pp. 5, 6 and 10-12 of translation; 2B and 2C, p. 8, explanatory text at pp. 12, 13) or 10 (Figs. 5B and C, p. 9) is literally "over" the compression-inducing layer 8 (Figs. 1C, 1D; p. 11 of translation) or 11 (Figs. 2A and 2B; compression is induced by removing the layer 11 from the backside, followed by thermal treatment, see pp. 12, 13 of translation). However, this interpretation depends on the orientation of the substrate, while the invention as recited in Applicant's claim 45 does not depend on such a strained interpretation of language or of what Kawamura et al. teach. A fair and accurate interpretation of what a reference does or does not teach or disclose does not depend on the orientation of the Figs. to the extent that this interpretation appears to. Accordingly, the anticipation rejection based on Kawamura et al. is defective and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Fifth, and in other words, claim 45 recites that the stress-inducing layer is formed on a first side of the substrate, while the refractory metal silicide is formed over the stress-inducing layer. This language comprehends forming the refractory metal silicide on the stress-inducing layer, even, for example, when the commonly-employed "sputter-up" approach is employed. As is well and widely known to those of ordinary skill in the relevant arts, "sputter-up" refers to a technique whereby the substrate is inverted above the sputtering target in order that any debris generated during the sputtering process cannot fall on the surface of the substrate that is being treated. There is no such disclosure or teaching of forming a refractory metal silicide over a stress

inducing layer in Kawamura et al. Accordingly, the anticipation rejection based on Kawamura et al. is defective and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Sixth, and put another way, the interpretation that the Examiner is giving to the term "over" gives the term "over" a meaning repugnant to the ordinary meaning of the term as it is employed herein and in accordance with the ordinary meaning of the term. More specifically, Applicants clearly are using the term "over" in the sense found, for example, in Merriam-Webster's Collegiate Dictionary, Tenth Ed. (Merriam Webster, Inc., Springfield MA, principal copyright 1993) at p. 827, "^{2}**over** *prep* ... **4 a** - used as a function word to indicate position upon ....". This can be understood by using the specification (see, e.g., p. 7, lines 22 and 23) to interpret the language of the claims (see MPEP §2111, entitled "Claim Interpretation; Broadest Reasonable Interpretation").

Giving a term a meaning repugnant to the ordinary meaning of the term or repugnant to the meaning consistent with the use of the term in the specification is improper, as is explained in more detail in MPEP §608.01(o), entitled "Basis for Claim Terminology in Description". This MPEP section states that "The meaning of every term used in any of the claims should be apparent from the descriptive portion of the specification with clear disclosure as to its import; and in mechanical cases, it should be identified in the descriptive portion of the specification by reference to the drawing, designating the part or parts therein to which the term applies. A term used

in the claims may be given a special meaning in the description. No term may be given a meaning repugnant to the usual meaning of the term."

Accordingly, the meaning given to the term "over" in making the rejection improperly gives the term "over" a meaning repugnant to the preferred dictionary definition as well as being repugnant to the meaning as used in the specification. For at least these reasons, the anticipation rejection based on Kawamura et al. is improper and should be withdrawn, and claims 45, 55, 57 and 58 should be allowed.

Seventh, and in response to the Examiner's reasoning as outlined on p. 10, the notion that a layer formed on one side of a wafer is "over" a layer formed on another side of the wafer is at best a strained interpretation of the word "over". This is explained below in more detail.

Patent illustrations of semiconductor devices typically are such that the substrate is shown at the bottom. However, this does not necessarily reflect their actual position during processing and is not represented as showing their position during manufacturing. Substrates are often oriented vertically during some types of processing, are laid flat in others, are inverted in some and adopt a variety of orientations in yet others (e.g., a planetary orbiting fixture that spins substrates through many orientations, with some in one position, and others in other positions at any one moment, during processing to provide an average uniform set of processing conditions).

For example, many types of metal films are formed by vacuum evaporation. Applicant is not aware of a single example of a vacuum

evaporation system that places the source above the part to be coated. One good reason for this is that a source that evaporates molten metal needs to contain the molten metal in some form of crucible. Placing such above the substrate (i) puts the crucible between the vapor source and the substrate, shadowing the substrate and (ii) renders the substrate vulnerable to drips or dribbles. At the same time, it is conventional in engineering publications to illustrate the formed film as being above or on a top surface of the substrate.

One reason for this is that when a substrate is placed in an optical microscopy inspection station, the "top", "front" or "upper" surface is the surface that can be inspected by the microscope. As a result, this surface is typically known as the "top" or "upper" surface.

Accordingly, there is not any logical relationship between the manner in which the component is illustrated and the relative positioning of the components during processing. The conclusion that the Examiner is drawing from the illustrations, viz., that they are representative of the relative positions of the component parts <u>during formation</u>, is at odds with the conventions in the industry for illustrating such.

Additionally, the Examiner explicitly cites these Figs. for the proposition that they show the components <u>as they are formed</u> and as they are recited in the claims. However, the Examiner has identified no teaching or disclosure in the reference in support of this conclusion. In other words, Kawamura makes no representation that the Figs. show the substrates <u>as they are being processed</u>. As a result, the conclusion that the Examiner is drawing from the

reference, that Kawamura et al.'s Figs. show the substrate in the orientation in which it is being processed, is without support in the reference. Kawamura is silent regarding substrate orientation during the various processing operations and thus cannot possibly support the interpretation that the Examiner is placing on these Figs.

For at least these seven reasons, the anticipation rejection of claim 45 and claims dependent therefrom based on Kawamura et al. is defective and should be withdrawn, and claim 45 and claims dependent therefrom should be allowed.

Claims 24, 45, 52-57 and 59-70 stand variously rejected as being unpatentable over various combinations including Apte et al. or Cabral et al. The unpatentability rejections are improper, as is explained below in more detail.

The Examiner states (p. 4) that Apte et al. teach introduction of stress-inducing Ge atoms into a titanium layer at col. 2, lines 65-67 and col. 3, lines 15 and 52-56. The Examiner is mistaken.

Apte et al. teach an amorphization implant of As (see col. 2, lines 65-67). Apte et al. also teach use of other ions for this purpose at col. 3, lines 52-56. Amorphization is distinct from inducing a compressive stress.

The Examiner states (p. 4) that the first implant is a compressive stress inducing implant. How could this possibly be true if Apte et al. teach (col. 2, line 1) that the amorphization implant may be carried out prior to the deposition of the titanium layer? If Apte et al. were relying on a compressive

stress or teaching how to induce a compressive stress, why would Apte et al. completely fail to articulate such? Why would Apte et al. teach that the implantation could take place prior to the deposition of the titanium if the objective of the implant were to induce compressive stress in the refractory metal silicide?

Apte et al. rely (col. 3, lines 2-5) on Paranjpe et al., U.S. Patent No. 6,376,372 for an explanation of the influence of an amorphization implant on silicide phases. Paranjpe et al. explain the significance of such at col. 1, lines 47-55, stating that:

> Another approach is to use a pre-react amorphization implant either prior to the titanium deposition or just after it, but in either case, before the silicide react step. This implant breaks the bonds of the polysilicon. The broken bonds yield an increased number of reaction sites for the silicide react and enhance the diffusion of silicon toward the growing silicide. This accelerates the silicide formation and thus reduces the silicide sheet resistance. However, even further reduction in silicide sheet resistance is needed.

As can be seen, Paranjpe et al. are not teaching introduction of these atoms for compressive-stress induction. This is made even clearer at col. 2, lines 44-65, stating that:

> A pre-react amorphization implant before titanium deposition breaks up grain boundaries and amorphizes/damages the surface region of the polysilicon. A pre-react amorphization implant immediately after titanium deposition additionally leads to some intermixing of the titanium and polysilicon at the interface, leading to a smoother silicide surface. The amorphized region 22 has broken silicon-silicon bonds. Thus, silicide formation in a subsequent silicide react step may be accelerated due to the increased number of reaction sites and due to enhanced diffusion of the silicon towards the growing silicide.

> The implant dose and energy of the pre-react amorphization implant are selected so that the damaged region lies entirely within the polysilicon that is consumed during the subsequent silicide react step. If the damaged region extends too far into the substrate and approaches the vicinity of the source/drain region, transistor characteristics such as off-current and the drain to source breakdown voltage are degraded. Therefore, heavy species such as arsenic, antimony, and germanium are preferable for amorphizing the substrate because they produce shallow implants and a more uniform damage distribution.

Those of skill in the art will recognize that choice of dose and implant energy determine the results that are achieved by an implantation. Paranjpe et al. do not teach implants intended to result in compressive stress and adjust the energy of such implants to place the high stopping power implanted species <u>within the polycrystalline silicon</u>. Accordingly, the statement that Apte et al. teach introduction of compressive stress inducing atoms into the titanium metal layer is in error, because Apte et al. do not teach compressive stress inducing atoms and do not teach introducing Ge into the Ti layer.

Additionally, and as noted by the Examiner, Apte et al. teach alloying of the Ti with Si after this implant. Such is not consistent with introduction of compressive stress inducing atoms to reduce the temperature of a C49->C54 phase transition. One reason for this is that neither the reference nor the Examiner provides reason to believe that the Ge then is capable of inducing compressive stress.

The Examiner states (p. 4) that Apte et al. disclose "providing second compressive stress inducing atoms Ge into the titanium silicide layer

comprising the first crystalline phase (col. 3, lines 49-56). The Examiner is mistaken.

Once again, Apte et al. refer to Paranjpe et al. Paranjpe et al. teach (col. 3, line 48 et seq.) an post-silicide <u>amorphization</u> implant. Following such, Paranjpe et al. teach (col. 3, line 51 et seq.) that anneals in a temperature range of 850-900 °C are desirable and give an example of 850 °C for 30 seconds. In contrast, Applicants teach that such prior art anneals can be replaced with (p. 9, lines 1-8) anneals at 700 °C with less stringent time requirements. Applicants teach (p. 12, lines 22-23) that exemplary anneal conditions include 600 °C, at 760 Torr for 20 seconds. It is abundantly clear that neither Apte et al. nor Paranjpe et al. teach compressive stress inducing atoms for any purpose.

The Examiner also states that Apte et al. teach formation of a compressive-stress inducing layer 36. Apte et al. teach (col. 4, lines 20-23) that the layer is intended to keep contaminants out. It is abundantly clear that neither Apte et al. nor Paranjpe et al. teach compressive stress inducing layers for any purpose. Apte et al. provide no teaching, disclosure, suggestion or motivation for any of Applicants' positively-recited stress inducing acts or features.

The Examiner states (p. 5) that "The claiming of a new use, new function or unknown property which is inherently present in prior art does not necessarily make the claim patentable. See In re Best, 562 F 2d 1252, 1254, 195 USPQ 430, 433 (CCPA 1977)." It would appear that the Examiner is

attempting to (i) equate the contamination-prevention layer 36 taught by Apte et al. with the compressive-stress inducing layer recited by Applicants, and (ii) equate the amorphization implants taught by Apte et al. with the compressive-stress inducing implants recited by Applicants, although the Examiner has not articulated such with clarity. If these are the Examiner's intentions, they are in error.

The physical properties of deposited thin films can be influenced by a variety of factors. In fact, semiconductor manufacturing is notorious for being sufficiently sensitive to relatively small perturbations in conditions to such an extent that such manufacturers rigorously control processing parameters. Additionally, such manufacturers vigorously and frequently test the processes as well as parts being manufactured to determine when deviations crop up and to remediate such effects immediately.

For example, silicon nitride films vary substantially in their physical properties, such as thermal expansion coefficient, depending on temperature of the substrate during deposition, presence or absence of other compounds in the film or the reaction chamber, method of deposition (e.g., CVD versus PECVD), stoichiometry of the resulting film, pressure during deposition, subsequent thermal history and numerous other variables. As a result, all semiconductor device manufacturing involves experimental determination of processing conditions and parameters, relative concentrations and the like to achieve a desired result.

In this case, Applicants identify (p. 9, lines 3-8 and p. 12, lines 22-23) specific effects resulting from the compressive-stress inducing techniques taught by Applicants and recited in their claims: (i) allowing the phase transition anneal temperature to be reduced to about 600 °C, reducing anneal time to about 20 seconds and (iii) relaxing pressure and temperature constraints on the annealing procedure. In contrast, Apte et al. teach (col. 4, lines 6-15) that "Temperatures approaching that used for the source/drain and gate anneal processes (e.g., on the order of 850° - 900 °C.) are desirable. One exemplary anneal is an anneal at 850 °C. for 30 seconds."

Accordingly, the Examiner has failed to establish any "inherent" property of the processes taught by Apte et al. that would anticipate or render unpatentable the subject matter recited in any of Applicant's claims. It is abundantly clear that Apte et al. are not providing a compressive-stress inducing layer or atoms, do not teach or disclose such and do not suggest or motivate such. In fact, Apte et al. is void of the word "compressive" or any logical equivalent thereto.

As such, Apte et al. cannot possibly teach or disclose the invention as recited in any of claims 24, 52-54, 59-66 or 68-70. Additionally, because Apte et al. fail to provide all of the positively-recited features of Applicant's claims 24, 52-54, 59-66 or 68-70, such as compressive stress inducing features, Apte et al. cannot possibly render claims 24, 52-54, 59-66 or 68-70 unpatentable.

Claim 45 recites "forming a compressive stress inducing material layer

over a first side of a substrate; forming a refractory metal silicide over the compressive stress inducing material layer", which is not taught, disclosed, suggested or motivated by the cited references. Claim 66 recites "disposing stress inducing material operationally coupled to the refractory metal silicide, disposing including introducing stress inducing atoms into the refractory metal silicide", which is not taught, disclosed, suggested or motivated by the cited references. Apte et al. are void of the word "compressive". There is simply no teaching, disclosure, suggestion or motivation for any compressive-stress inducing features anywhere in Apte et al. Kawamura fails to cure these deficiencies for reasons noted above and also as noted below.

Kawamura et al. teach (¶ 3) that C54 is formed at temperatures of 750 °C and above, and explicitly teach (¶¶ 19, 40, 45 and 63) anneal temperatures of 800 °C or higher. Kawamura et al. do not recognize the problems resulting from such anneals and thus there is no motivation in Kawamura et al. to attempt to reduce the anneal temperature using the techniques and features taught by Applicants and recited in Applicants claims. There is no motivation in either reference to combine their teachings.

As a result, the proposed combination does not and cannot provide the invention as recited in any of Applicant's claims and thus cannot render Applicant's claims unpatentable. Simply stating a conclusion that "it would have been obvious" to combine teachings from references or to modify or augment teachings from a reference does not meet the standards for a rejection under 35 U.S.C. §103(a) as set forth in The Manual of Patent

Examination Procedure at §706.02(j) and §2142, entitled "Contents of a 35 U.S.C. 103 Rejection" and "Legal Concept of Prima Facie Obviousness", respectively.

The latter MPEP section states that in order to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. There is no motivation identified anywhere to modify the references to attempt to arrive at the subject matter of Applicant's claims.

This MPEP section also states: "Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest **all** the claim limitations."

Since the Apte et al. reference is silent with respect to providing compressive stress features in conjunction with a metal layer, modifying their teachings cannot possibly provide the invention as recited in any of Applicant's claims. As a result, there cannot possibly be a reasonable expectation of success from modifying the teachings of the reference. Thus, the third prong of the test cannot be met.

This MPEP section further states that "The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)." Since neither

of these prongs of the test are met at all, such can hardly be found in the prior art.

These principles are reinforced by noting that it is well established that old elements may be combined to provide results not suggested by references and thereby to be patentable. "The patentability of such combinations is of ancient authority." *Prouty v. Draper*, 41 U.S. (16 Pet.) 336, 341 (1842); *Eames v. Godfrey*, 68 U.S. (1 Wall.) 78,79-80 (1863); *Gill v. Wells*, 89 U.S. (22 Wall.) 1, 25 (1874); see also H.T. Markey, *Why not the Statute?*, 65 J. Pat. Off. Soc'y., 331, 333-34 (1983) ("virtually all inventions are 'combinations', and ... *every* invention is formed of 'old elements' .... Only God works from nothing. Man must work with old elements"). These principles of patent law are repeated in many other cases, including *In re Wright*, 6 USPQ2d 1959 (CAFC) and *Fromson v. Advance Offset Plate, Inc.*, 225 USPQ2d 26 (CAFC).

The latter case further states that "There is no basis in the law, however, for treating combinations of old elements differently in determining patentability. See *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d at 1540, 218 USPQ at 880." As noted in *Diamond v. Chakrabarty*, 206 USPQ 193, 196, the Supreme Court stated that "We have also cautioned that courts "should not read into the patent laws limitations and conditions with the legislature has not expressed." *United States v. Dubilier Condenser Corp.*, 289 U.S. 178, 199, 17 USPQ 154, 162 (1933)."

As a result, the unpatentability rejections of claims 45, 55-57 and 67 fails all three components of the test for an obviousness rejection as set forth in the MPEP. Accordingly, the recitation of claims 45, 55-57 and 67 is not rendered unpatentable by combining or modifying the teachings of the references. For at least these reasons, the rejection of claims 45, 55-57 and 67 should be withdrawn, and claims 45, 55-57 and 67 should be allowed.

Claim 24 recites "A method of forming a refractory metal silicide layer comprising: forming a titanium metal layer over a silicon containing substrate; providing stress inducing atoms into the titanium metal layer, the compressive stress inducing atoms being larger than silicon atoms; after the providing, first annealing the titanium metal layer containing the compressive stress inducing atoms to form a titanium silicide layer substantially of a first crystalline phase; and second annealing the titanium silicide layer substantially of the first crystalline phase under conditions effective to transform said titanium silicide layer to a more dense layer substantially of a second crystalline phase", which is not taught, disclosed, suggested or motivated by Cabral et al.

The Examiner states (pp. 5 and 6) that Cabral et al. disclose a method including "providing compressive stress inducing atoms ... larger than silicon atoms (e.g. W in Ti-alloy, col. 11 lines 48-52 and col. 10 lines 15-18)." The Examiner is mistaken.

Cabral et al. are silent with respect to providing compressive stress inducing atoms. In fact, neither the word "compressive" nor any equivalent

thereto appear anywhere in Cabral et al., and the Examiner has failed to even attempt to show where such might be found in Cabral et al.

Cabral et al. teach that W may be alloyed with titanium (col. 11, lines 25-30). Alloying metals is not arbitrarily interchangeable with Applicant's positive recitation of providing compressive stress inducing atoms, as recited in claim 24. Cabral teaches (col. 10, lines 1-2) introduction of refractory metals to reduce the phase transformation temperature of the alloy.

As noted above with respect to Apte et al. and Paranjpe et al., the relative size of the constituent atoms is but one of many factors determining the role that these constituents actually play. The Examiner has offered no evidence at all to support the notion that alloying tungsten with titanium results in compressive stress. Further, no such evidence is contained in the reference.

In the instant application (p. 10, line 22 through p. 11, line 7), compressive stress inducing atoms larger than silicon atoms of the silicide, such as Ge, W and Co or mixtures thereof, are provided within the first crystalline phase material prior to anneal. Suggested techniques for introducing such include ion implantation and gas diffusion.

Ion implantation techniques favor placement of the stress inducing atoms in interstitial locations, rather than substitutional locations, within the silicide material. This is one of several reasons that implanted species are not electronically active until an activation anneal follows the implantation (see, e.g., Wolf and Tauber, *Silicon Processing for the VLSI Era*, Vo. I,

Process Technology, copyright 1986, Lattice Press, Sunset Beach, CA, p. 242, 1ST ¶ and 303, 2ND full ¶). Interstitial atoms logically give rise to compressive stress (see., e.g., pp. 539-542 of Omar, *Elementary Solid State Physics, Principles and Applications*, copyright 1975, Addison Wesley Publishing Company, Inc., Reading MA) because such atoms distort the material by expanding it. Substitutional alloys, such as W-Ti or TiSi, on the other hand, do not predominantly involve atoms in interstitial locations and thus do not logically give rise to compressive stress.

Gas diffusion in polycrystalline materials tends to give rise to accumulation of the diffusing species at grain boundaries (p. 261, Wolf). Again, such logically gives rise to compressive stress because such materials distort the material by expanding it.

As a result, the Examiner's statements (p. 5) that Cabral teach "providing compressive stress inducing atoms being larger than silicon atoms" is without foundation in Cabral et al. and is inconsistent with general principles of solid state physics. If the Examiner wishes to assert some logical connection between "stress inducing atoms" and the teachings of Cabral et al., the Examiner needs to provide some evidence, either within Cabral et al. or in some other form, establishing that some such logical connection exists. The record is currently void of any such evidence.

Since the statement that Cabral et al. teach compressive stress inducing material is not supported by the references, it must be made on the basis of personal knowledge of the Examiner's. Applicants note the

requirements of MPEP §1.104, entitled "Nature of examination", which states that "When a rejection in an application is based on facts within the personal knowledge of an employee of the Office, the data shall be as specific as possible, and the reference must be supported, when called for by the applicant, by the affidavit of such employee, and such affidavit shall be subject to contradiction or explanation by the affidavits of the applicant and other persons." In the event that the Examiner persists in stating that Cabral et al. teach compressive stress inducing atoms, Applicants call for such an affidavit or other objective evidence to support this position. Alternatively, the statement that Cabral et al. teach compressive stress inducing materials is without support and should be retracted, and claims 24 and 52 should be allowed.

Stating a conclusion that "it would have been obvious" to combine teachings from references or to modify or augment teachings from a reference does not meet the standards for a rejection under 35 U.S.C. §103(a) as noted above with respect to MPEP §2142.

The first criterion in this MPEP section states that there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine reference teachings. The Office Action fails to show that the subject matter of claims 24 and 52 is suggested or motivated by the teachings of the reference(s).

The second requirement is that there must be a reasonable expectation of success. The third requirement is that the prior art reference (or references when combined) must teach or suggest all of the claim limitations.

Since the Cabral et al. reference is silent with respect to providing compressive stress inducing atoms into the titanium metal layer, modifying their teachings cannot possibly provide the invention as recited in any of Applicant's claims. As a result, there cannot possibly be a reasonable expectation of success from modifying the teachings of the reference. The unpatentability rejection fails all three components of the test for an obviousness rejection as set forth in the MPEP.

Accordingly, Cabral et al. (i) fail to provide the elements of the invention as recited in claim 24, as is required for a finding of either anticipation or unpatentability, (ii) fail to enable the invention as recited in claim 24, as is additionally required for a finding of anticipation, (iii) fails to motivate or suggest the claimed invention and (iv) fails to provide any of the three elements of the test for unpatentability as set forth in the MPEP.

As such, it is inconceivable that Cabral et al. could anticipate the invention as recited in claim 24 or claims dependent therefrom. Additionally, it is inconceivable that Cabral et al. could render the invention as recited in any of these claims unpatentable. For at least these reasons, the rejection of claim 24 and claims dependent therefrom should be withdrawn, and claim 24 and claims dependent therefrom should be allowed.

New claims 71-78 are supported at least by text appearing at p. 7, line 5 through p. 17, line 3 of the application as originally filed. No new matter is added by new claims 71-78. New claims 71-78 distinguish over the art of record and are allowable.

In summary, Applicants respectfully assert that claims 24, 45 and 52-78 are in condition for allowance. Action to that effect is earnestly sought. If, however the Examiner's next action is anything other than a Notice of Allowance, the Examiner is requested to call the undersigned to schedule a telephonic interview. The undersigned is available during normal business hours, Pacific Coast Time.

Respectfully submitted,

Dated: Aug. 30, 2002 By: ______________________

Frederick M. Fliegel, Ph.D.
Reg. No. 36,138

Version with markings to show changes made ✓

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. 09/233/377
Filing Date .... January 18, 1999
Inventor .... Gurtej S. Sandhu et al.
Assignee .... Micron Technology, Inc.
Group Art Unit 2813
Examiner .... T. Pham
Attorney's Docket No. MI22-1114
Title: .... Method of Forming a Refractory Metal Silicide (as Amended)

37 CFR §1.121(b)(1)(iii) AND 37 CFR §1.121(c)(1)(ii) FILING REQUIREMENTS TO ACCOMPANY RESPONSE TO MAY 8, 2002 OFFICE ACTION

Deletions are bracketed, additions are underlined.

In the Specification

The paragraph spanning p. 9, line 9 through p. 10, line 6, has been amended as shown below:

The above first described preferred embodiment is but one example of a method of providing a stress inducing material (i.e., layer 16) operatively adjacent a crystalline material of a first crystalline phase (i.e. layer 14) to be effective to induce stress (i.e. in this example compressive stress) as the material is annealed to a second crystalline phase. An alternate example of providing a stress inducing material operatively adjacent a crystalline material to be transformed to a secondary crystalline phase is to provide such stress inducing material under or inwardly of the first crystalline phase material, as described with reference to Figs. 3 - 4. Such illustrates a semiconductor wafer fragment in process generally with reference numeral 18. In Fig. 3, such comprises a substrate [20] 12, for example bulk monocrystalline silicon or layers of material, having an overlying stress inducing material layer 22. A layer 24 of crystalline material of the first crystalline phase is provided outwardly of layer 22, with layer 22 thus being inwardly of or under layer 24 and in the illustrated example in contact therewith. In the example refractory metal silicide transformation of a C49 phase to a C54 phase accompanied by a volume reduction, layer 22 ideally also has a coefficient of expansion which is less than the coefficient of expansion of layer 24. Such facilitates putting layer 24 in compressive stress during phase transformation. Example materials include those provided above for layer 16.

In the Drawing

Fig. 4 has been amended as shown on the marked-up-in-red sheet of drawing enclosed herewith.

In the Claims

59. (Amended) A method of forming a refractory metal silicide layer comprising:

forming a titanium metal layer over a silicon containing substrate;

providing compressive stress inducing atoms comprising germanium into the titanium metal layer;

first annealing the titanium metal layer containing the compressive stress inducing atoms to form a titanium silicide layer substantially comprising a first crystalline phase after providing compressive stress inducing atoms; and

second annealing the titanium silicide layer substantially comprising the first crystalline phase under conditions effective to transform the titanium silicide layer to a denser layer substantially comprising a second crystalline phase.

62. (Amended) A method of forming a refractory metal silicide comprising:

forming a refractory metal silicide over a first side of a substrate, the refractory metal silicide comprising a first crystalline phase;

providing stress inducing atoms comprising germanium into the refractory metal silicide;

forming a compressive stress inducing material layer over the refractory metal silicide; and

[after forming the refractory metal silicide comprising the first crystalline phase,] <u>subsequently</u> annealing the refractory metal silicide comprising the first crystalline phase to convert the first crystalline phase to a second crystalline phase.

63. (Amended) The method of claim 62, wherein forming the compressive stress inducing material layer comprises forming the compressive stress inducing material layer over the first side of the substrate and wherein [forming the refractory metal silicide over the first side of] the substrate comprises [forming the refractory metal silicide over the first side of] a silicon containing substrate.

66. (Amended) A method of forming a refractory metal silicide comprising:

forming a refractory metal silicide over a first side of a substrate, the refractory metal silicide comprising a first crystalline phase;

disposing stress inducing material operationally coupled to the refractory metal silicide, disposing including introducing stress inducing atoms into the refractory metal silicide; and

[after forming the refractory metal silicide comprising a first crystalline phase,] <u>subsequently</u> annealing the refractory metal silicide comprising a first crystalline phase to convert the first crystalline phase to a second crystalline phase.

Claims 71-78 have been added.

END OF DOCUMENT